GEMMAE OF THE MARCHANTIALES FROM THE WINTON FORMATION (MID-CRETACEOUS), EROMANGA BASIN, QUEENSLAND

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Hepatophyte gemmae are described from latest Albian sediments of the Winton Formation, Eromanga Basin, Queensland. The discoid gemmae are borne on a single-celled stalk and midway along each lateral margin there is a shallow notch in which is situated a growing point. The gemmae are comparable to those of extant Marchantiales and are referred to *Marchantites marguerita* sp. nov. ❐ *Marchantiales, gemmae, Late Albian, Eromanga Basin, Queensland.*

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Hepatophytes are believed to have formed an important component of the mid-Cretaceous vegetation of Australia as indicated by the widespread, sometimes abundant occurrence of diverse hepatic-like spores in Albian and Cenomanian sediments (Dettmann, 1994). However, apart from the likely affinity of *Triporoletes* Mtchedlishvili to the Marchantiales, ordinal or family alliance of the sporae dispersae remains speculative. Further support for the presence of the Marchantiales in the Albian flora of southeastern Australia is provided by the thalli taxa, *Hepaticites discoides* Douglas and *H. profusus* Douglas, both of which are accepted as representatives of a possibly extinct, marchantialean group (Krassilov & Schuster, 1984). Spores associated with fertile *H. discoides* conform with the spore genus *Triporoletes* and its junior synonym *Rouseisporites* Pocock (Douglas, 1973).

In contrast to the common occurrence of hepatophyte megafossils, particularly *H. profusus*, at some Albian localities in the Otway Basin (Douglas, 1973), there are no records of hepatophyte thalli in Albian-Cenomanian megafloras described from elsewhere in Australia. These include the Burrum and Styx compression floras (Walkom, 1919); the Winton flora, known from impressions and permineralised cones and foliage taken from outcrops (McLoughlin et al., 1995; and references cited therein); and recently described compressions and cuticles recovered from core material of subsurface strata (Pole, 1999; 2000, Pole & Douglas, 1999). During palynological processing of a core from the Winton Formation in GSQ Thargomindah No. 3, numerous mesofossils including megaspores, fern sporangia, and discoid hepatophyte gemmae were recovered. This account details the gemmae and illustrates associated fern sporangia.

MATERIAL AND METHODS

The gemmae were isolated from a siltstone intersected at 163.5m in GSQ Thargomindah No. 3, a continuously cored stratigraphic borehole drilled by the Geological Survey of Queensland at 27°16'S, 142°55'E, 120km NW of Thargomindah within the Eromanga Basin, SW Qucensland (Figs 1, 2). A routine check of organic matter extracted from the sediment after treatment with 50% hydrofluoric acid followed by thorough washing in distilled water revealed the presence of numerous small discoid plant fossils up to 440μm in diameter. These were picked from the residue and transferred to small petri dishes prior to mounting in glycerine jelly on glass microscope slides. No further chemical treatment was required, and indeed mild oxidation in dilute nitric acid resulted in destruction of the disc-shaped fossils. After recognising that the discs represented hepatophyte gemmae, a thorough search was undertaken for any associated hepatophyte tissues; none was found, except for occasional hepatophyte-like dispersed spores (*Triporoletes reticulatus* (Pocock) Playford, *T. simplex* (Cookson & Dettmann) Playford, and *T. radiatus* (Dettmann) Playford). Other plant meso/microfossils represented in the residue included fern sporangia, woody tissues and palynomorphs. Fern sporangia were picked from unoxidised portions of the residue and mounted either in glycerine jelly for light

FIG. 1. Map of Australia showing location of GSQ Thargomindah No. 3 and Eromanga Basin.

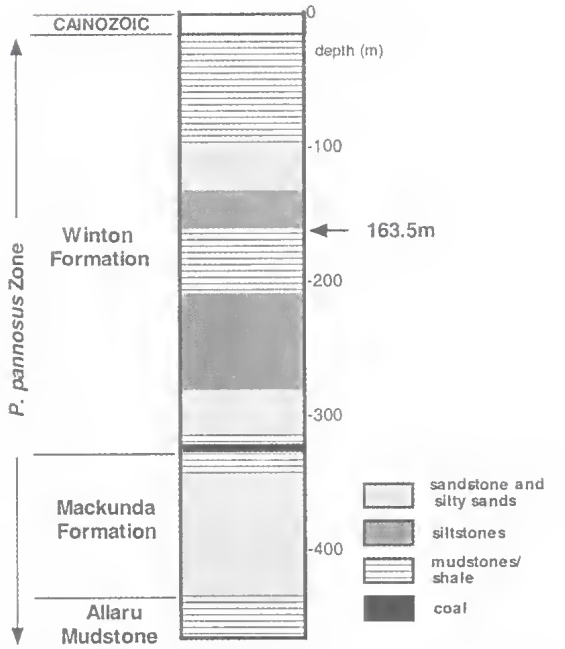

FIG. 2. Stratigraphic sequence in GSQ Thargomindah No. 3, and sampling horizon.

microscope examination or on stubs and sputter coated with gold for scanning electron microscope analysis. Palynomorphs were extracted after treatment with nitric acid for 2 minutes, followed by thorough washing in distilled water, brief immersion in 1% ammonium hydroxide and further washing in distilled water prior to mounting for light microscope analyses.

The palynoflora contained in the sediment indicates assignment to the upper part of the *Phimopollenites pannosus* spore-pollen Zone (of Helby et al., 1987) and thus a latest Albian age.

Gemmae of living *Marchantia berteroana* Lehm. et Lindenb., *Lunularia cruciata* (L.) Dum. and *Neohodgsonia mirabilis* (Perss.)Perss. were examined after clearing in a mixture of glacial acetic acid and hydrogen peroxide in proportions 7:1 to remove chlorophyll and cell contents. The gemmae were then washed in distilled water and mounted in glycerine jelly on microscope slides.

Type and other figured specimens are lodged in the Queensland Museum, Brisbane. Registered numbers of that institution are designated in Table 1.

SYSTEMATIC PALAEONTOLOGY

HEPATOPHYTA
MARCHANTIALES

Marchantites Brongn., 1849
emend. Walton, 1925

TYPE SPECIES. *Marchantites sezannensis* Brongn., 1849.

Marchantites marguerita sp. nov.
(Fig. 3A-K)

ETYMOLOGY. For the late Margaret Derham, beloved sister and friend of MED.

MATERIAL. HOLOTYPE: QMF50093. Fig. 3A-C. Gemma discoid, 430μm long, 350μm greatest width, with a stalk scar at one end, and a notch on opposite sides on the periphery situated lateral to the stalk. Cells polygonal, 30-40μ in diameter, with anticlinal walls up to 6μm high.

DIAGNOSIS. Gemmae discoid, 1-2 cells thick and sometimes with a short, one-celled stalk up to 60μm long and 60μm wide. In outline each gemmae is bilaterally symmetrical about the vertical axis. A pair of shallow notches occurs opposite to each other on the perimeter of each gemmae midway between the apex and stalk. Cells adjacent to stalk elongate (up to 80μm long, 30-40μm wide), elsewhere isodiametric, pentagonal to hexagonal, 25-40μm in diameter

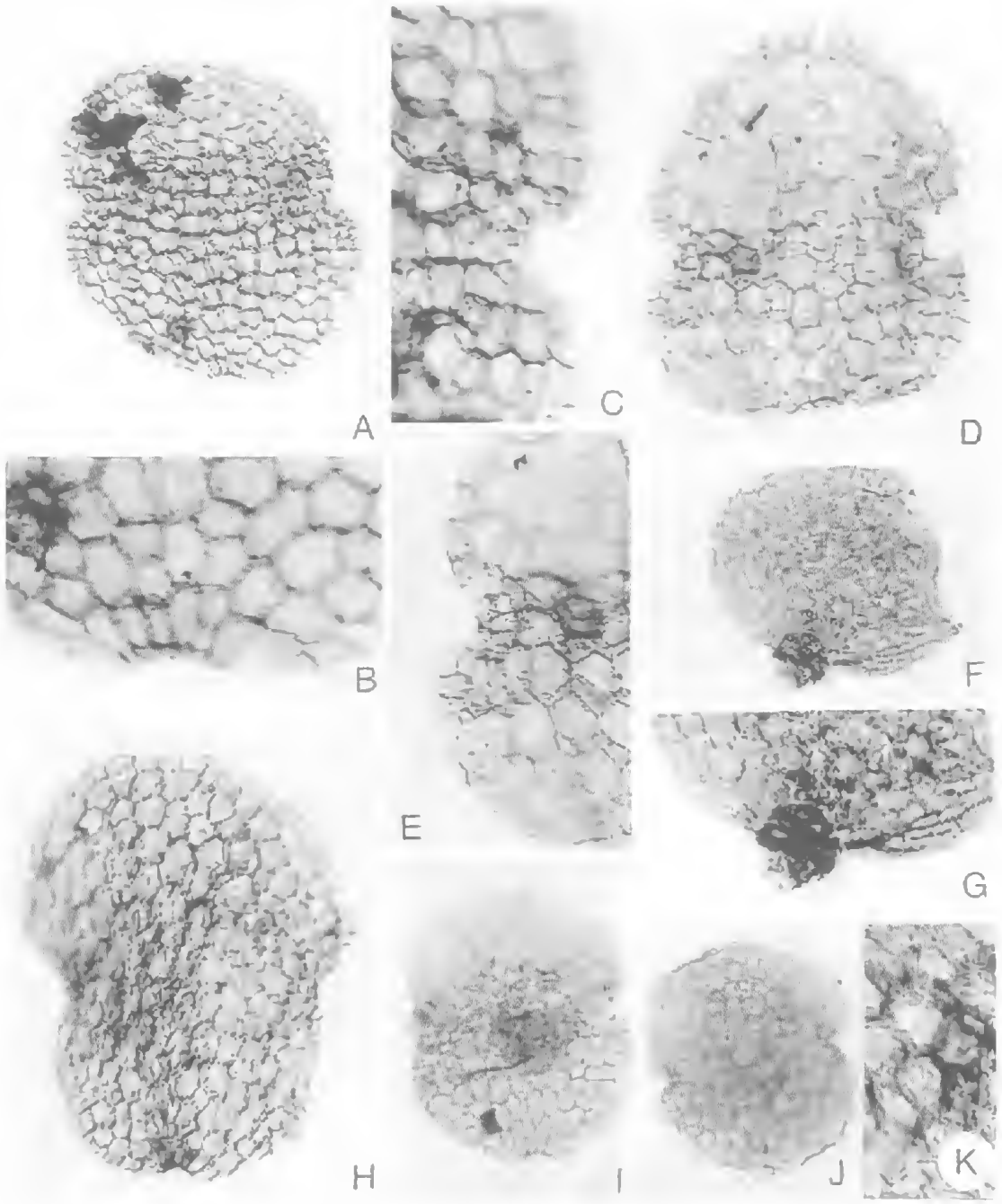

FIG. 3. Micrographs of *Marchantites marguerita* sp. nov.; A-C, holotype. A, ×100; B, basal cells at site of stalk attachment ×300; C, cells in region of notch, ×300; D,E, whole specimen, ×200, and detail of notch cells, ×300; F,G, specimen with stalk attached, ×100, and detail of stalk cell, ×150; H, I, specimen ×150 and ×100; J, K, specimen, ×100, and detail of cells, ×300.

and with anticlinal walls 2-6μm high, but grading to 20μm in diameter at the growing points centred in each lateral notch.

DIMENSIONS. (longitudinal × lateral dimensions) 200-(320)-440μm × 160-(270)-400μm (20 specimens).

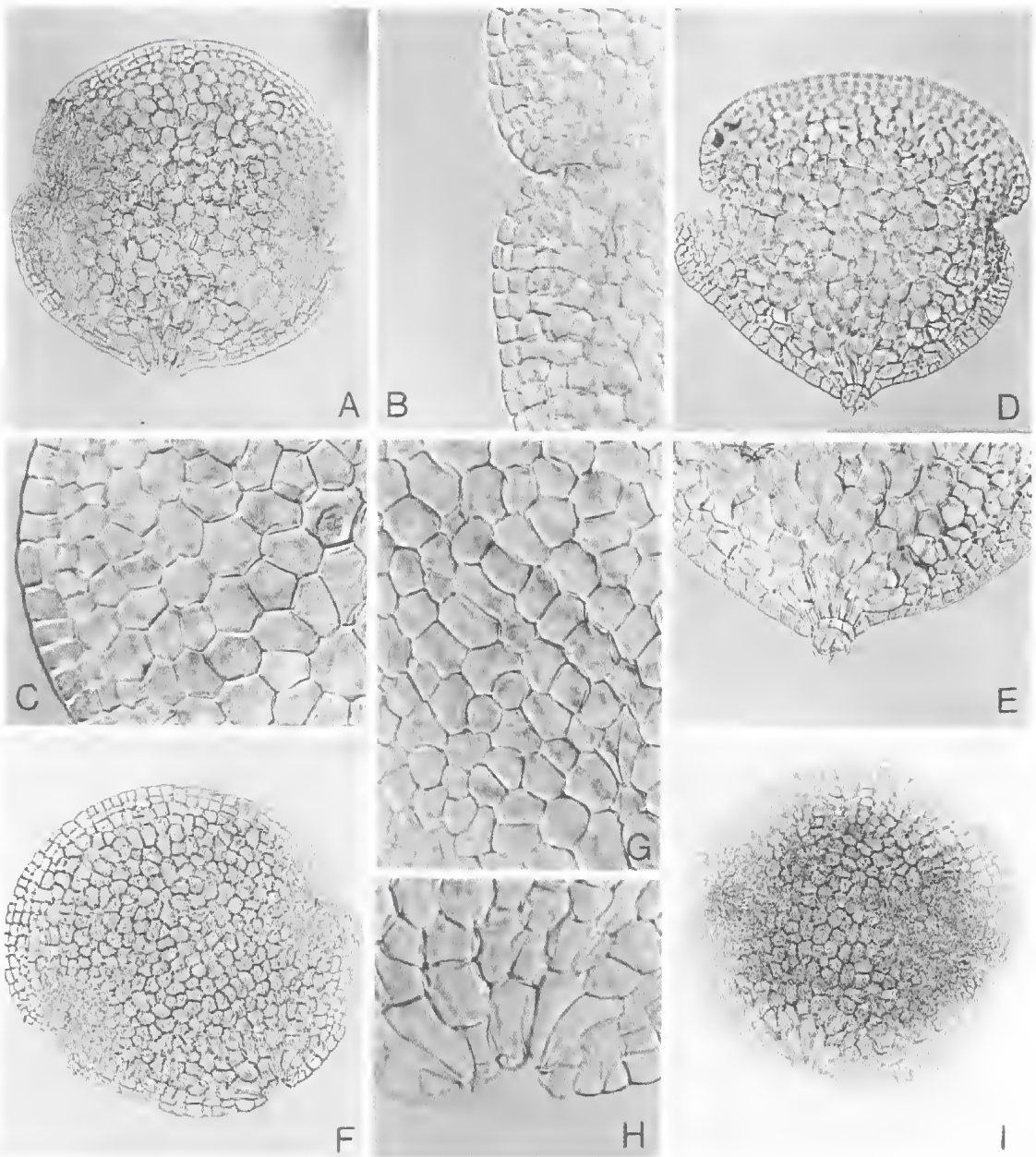

FIG. 4. A-E, Gemmae of *Marchantia berteroana* Lehm. et Lindenb; A, × 100; B, C, detail of notch and peripheral cells, × 300; D,E, specimen with stalk cell, × 100 and detail of stalk, × 150. F-I. Gemmae of *Lunularia cruciata* (L.) Dum; F-H, specimen, × 100, and detail of cells in central and basal regions, × 300; I, specimen, × 100.

TYPE LOCALITY. GSQ Thargomindah 3, 163.5m; upper *P. pannosus* Zone, latest Albian.

REMARKS AND COMPARISON. In possessing a single-celled stalk and peripheral lateral notches in each of which is centred a small growing point, the discoid fossils are morphologically consonant with gemmae of *Marchantia* L. (Marchantiaceae) and *Lunularia* Adanson (Lunulariaceae). Cells of *Marchantites marguerita* are more similar in size (25-40μm in diameter) to those of gemmae of *Marchantia berteroana* (cells 25-40μm in diameter; Fig.

4A-E) than those of *Marchantia polymorpha* L. (Smith, 1955: fig. 30; 15-30μm in diameter) and *Lunularia cruciata* (cells 15-30μm; Fig. 4F-I). The monospecific *Neohodgsonia* (*N. mirabilis*) H. Persson, (Marchantiaceae) also has disc-shaped gemmae, but they differ from those examined of *Marchantia* and *Lunularia* in possessing only one growing point associated with a lateral or subapical notch. Plate-like gemmae occur in several extant taxa of the Metzgeriales, but in these there is only one growing point, which is situated at the margin opposite to the stalk (Watson 1964).

The likely Marchantiales origin of the fossil gemmae may argue for assignment to *Marchantiolites* Lunblad, also demonstrated to be consistent with the Marchantiales. However, *Marchantiolites* is based on thalli with rhizoids on the undersurface and air pores on the upper surface, and is thus inappropriate for the gemmae described here. Pending recovery of the gemmae in organic association with hepatophyte thalli, the fossils are included in the broader category *Marchantites*.

DISCUSSION. Because of their firm thalli and preference for growing on mineral soil adjacent to stream banks, members of the Marchantiales are likely candidates for burial and subsequent fossilisation. Indeed from the Triassic onwards marchantioid-type thalli are well known (Krassilov & Schuster, 1984). It is therefore surprising that *Marchantia*-like gemmae have not been previously recognised.

The similarity of *Marchantites marguerita* to gemmae of extant *Marchantia* and *Lunularia* suggests that growth habitats of the Winton hepatophytes were within the range of those occupied by the extant genera, both of which are restricted to temperate climates. The Thargomindah region of the Eromanga Basin was situated at ~55°S during the latest Albian. Palaeotemperature data are lacking but those deduced from belemnites and bivalves from the underlying marine sequence indicate sea water temperatures of 12-16°C (Dettmann et al., 1992). Temperatures adduced from Global Grossplots are near 15°C (Frakes, 1997) and from other sources approximate 10°C (Frakes, 1997, Fig. 4). Today, the 15°C MAT isotherm passes through southern New South Wales/northern Victoria at latitudes close to 35°S and the 10°C MAT isotherm to the south of Tasmania (Anon, 1988).

Associated with the fossil gemmae are numerous fern sporangia, one type possibly osmundaceous (Fig. 5A-D; apical annulus and containing in situ *Osmundacidites* cf. *wellmanii* Couper), and another with a vertical annulus and containing *Cyathidites minor* Couper (Fig. 5E-I). Also represented are lycophytic and hydropteridean megaspores and a restricted spore-pollen flora dominated by filicean spores referable to *Ruffordiaspora* Dettmann & Clifford (Schizaeaceae), *Baculatisporites* Thomson & Pflug and *Osmundacidites* Couper (Osmundaceae), and *Cyathidites* Couper. Hepatic spores (*Triporoletes reticulatus*, *T. simplex* and *T. radiatus*), gymnosperm (*Araucariacites* Cookson ex Couper, *Podocarpidites* Cookson ex Couper, *Microcachryidites* Cookson ex Couper) and dicotyledonous angiosperm pollen (*Phimopollenites* Dettmann) occur in low frequencies.

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FIG. 5. A, B, Osmundaceous sporangia, ×150. C, D, *Osmundacidites wellmanii* Couper, ×750; C, spore associated with sporangium, D, dispersed spore. E, *Baculatisporites comaumensis* (Cookson) Potonié, dispersed spore ×750. F-I, Fern sporangia with vertical annulus; F, ×400, G, with in situ spores, ×200, H, I, ×250. J, *Cyathidites minor* Couper, spore from sporangium, ×750. K, *Triporoletes simplex* (Cookson & Dettmann) Playford, dispersed spore, ×750.

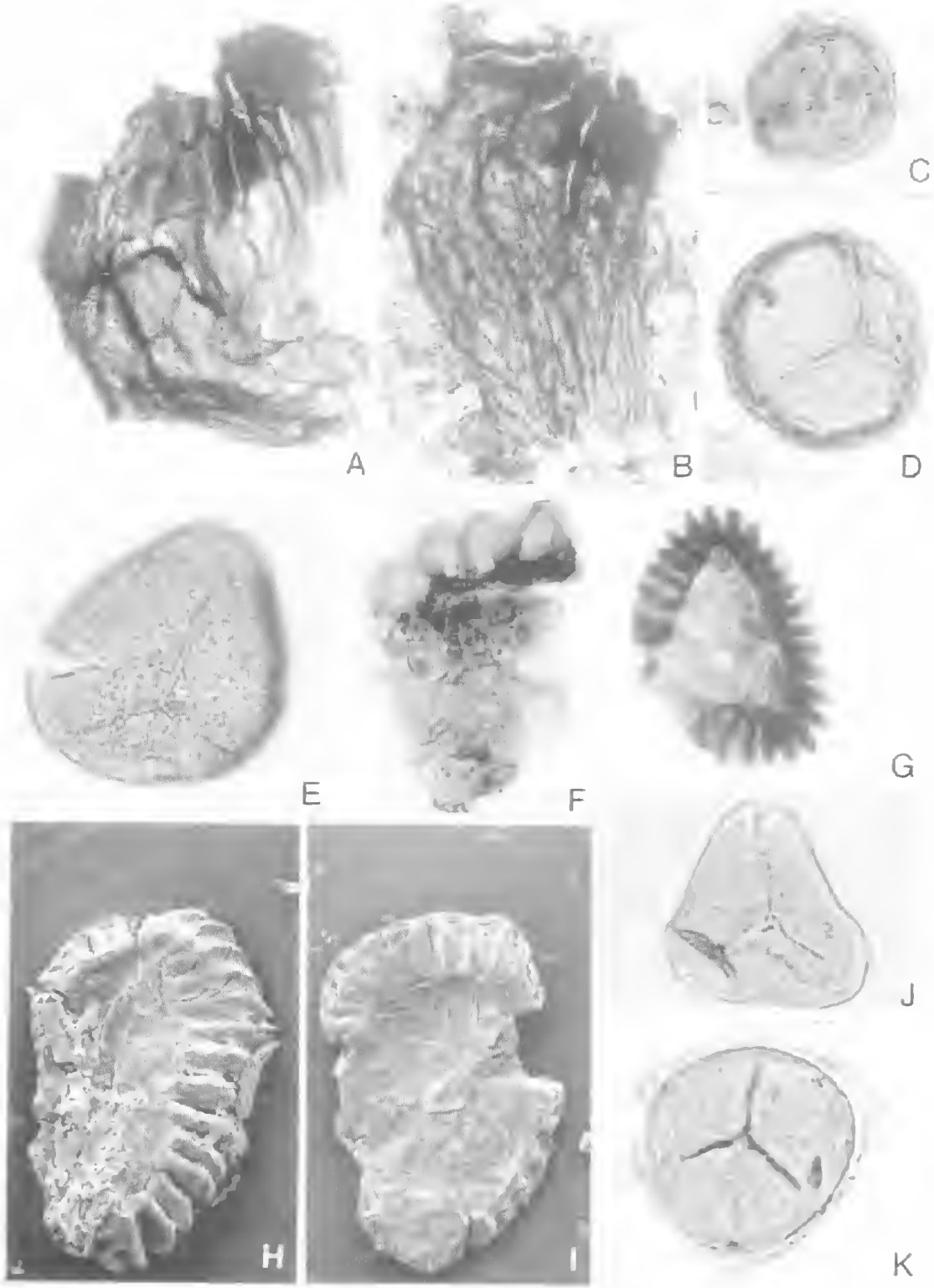
A
B
C
D
E
F
G
H
I
J
K

TABLE 1. Register of figured specimens. * denotes holotype.

Taxon/Fig. No.	Slide	Co-ordinates (England Finder)	Registered No.
Gemmae			
Lunularia cruciata			
Fig. 4F-H	LUN/2	K28/1	QMF50110
Fig. 4I	LUN/1	L34/2	QMF50111
Marchantia berteroana			
Fig. 4A-C	MAR/1	Q41	QMF50112
Fig. 4D,E	MAR/1	K26/3-4	QMF50113
Marchantites marguerita			
Fig. 3A-C *	THA 163.5/A2	M27	QMF50093
Fig. 3D,E	THA 163.5/A5	E37/1	QMF50094
Fig. 3F,G	THA 163.5 /A11	O52/4	QMF50095
Fig. 3H	THA 163.5/A8	G29	QMF50096
Fig. 3I	THA 163.5/A2	C16/4	QMF50097
Fig. 3J,K	THA 163.5/A1	K41/1	QMF50098
Sporangia			
Osmundaceous sporangia			
Fig. 5A	THA 163.5/A7	P38	QMF50099
Fig. 5B	THA 163.5/K	F29/4	QMF50100
Sporangia with vertical annulus			
Fig. 5F	THA 163.3/A6	J33/3	QMF50101
Fig. 5G	THA 163.5/A3	H27	QMF50102
Fig. 5H	THA 163.5/A16	L38/1	QMF50103
Fig. 5I	THA 163.5/A16	M37	QMF50104
Spores			
Baculatisporites comaumensis			
Fig. 5E	THA 163.5/2	F31	QMF50105
Cyathidites minor			
Fig. 5J	THA 163.5/2	K50/2	QMF50106
Osmundacidites wellmanii			
Fig. 5C	THA 163.5/2	J45/3	QMF50107
Fig. 5D	THA 163.5/2	Q46/4	QMF50108
Triporoletes simplex			
Fig. 5K	THA 163.5/2	J43	QMF50109

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